Original article

A Five-Year Retrospective Study on Fractured Orbital Walls: A Spearman Correlation Analysis

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Abstract

Objective: The purpose of this study is to find propotion of fractured orbital walls in the maxillofacial trauma cases and its associated maxillofacial fracture treated in the Oral Maxillofacial Clinic Oral Maxillofacial ward and operation theatre of Hospital USM in Kelantan, Malaysia. ***Materials and methods*:** From July 2013 to June 2018, records of patients who sustained maxillofacial fractures and presented them to the Accident and Emergency Department, Oral Maxillofacial Clinic, Hospital USM were reviewed, recorded, and analyzed. There are 294 patients whose data has been collected because they met the inclusion criteria. Each patient with a complete medical record was reviewed. Data were collected under the variables: Zygomatic Complex, Zygomatic Arch, Nasal, Maxillary Sinus, Le Fort I, Le Fort II, Le Fort III, Orbital Wall, Alveolar Process, Symphysis of Mandible, Condyle of Mandible, Ramus of Mandible, Maxillary Bone and Mandibular Bone of maxillofacial fracture. The fractured orbital walls in these cases was reviewed. At the first stage, all the selected variables will be screened for their important clinical point of view. The SPSS software version 26.0 was used to determine all possible factors contributing to orbital wall fracture. ***Results:*** This was a retrospective cross-sectional analysis of the medical records of 294 patients with maxillofacial fracture treated in the Oral Maxillofacial Clinic and Oral Maxillofacial ward, Hospital USM. There were 228 (77.3%) men and 66 (22.4%) women included in this study. The most common age range is 11-20 years (39.8%), 21-30 years (26.2%). Maxillary Bone Fracture (0.371; p <0.05), Maxillary Sinus Fracture (0.180; p <0.05), Zygomatic Arch Fracture (0.127; p <0.05) were found to be the most affected site, which had a positive correlation with an orbital fracture of the maxillofacial trauma cases. A path analysis based on the Spearman correlation was developed by taking into account significant correlations at the level of 0.05. ***Conclusion:*** Using the matrix spearman correlation, multiple response analysis (MRA), path analysis, we discovered a clear connection between orbital wall fracture and several other factors. This discovery will aid in the understanding of the most common fracture and the causes of orbital wall fracture in maxillofacial trauma. The Zygomatic Arch Fracture, Maxillary Sinus Fracture, and Maxillary Bone Fracture were found to have a significant relationship with the orbital wall when the significance level was set at 0.05.

Keywords: Orbital Wall, Maxillofacial Injury, Matrix Spearman Correlation, Path Analysis, and Multiple Response Analysis (MRA)

Bangladesh Journal of Medical Science Vol. 21 No. 04 October'22 Page : 744-750
DOI: https://doi.org/10.3329/bjms.v21i4.61362

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1. Introduction

One of the common cases faced by the modern hospital today is traumatic injury. Despite various measured taken such as safety of vehicle and advanced technology in making safest road as possible, traumatic injury is still in common. Trauma is referred to as a anatomical deformity caused by uncontrolled force or an acute source of energy coming into direct contact with the body with the body's disaster to tolerate it. Maxillofacial trauma or injury is one of the most problems faced by the global health issues today. Oral and maxillofacial trauma causes may be countless including motor vehicle accidents, assault, animal attack, war, shots by guns or other weapons, fracture in sport, falls, fights, industrial accidents, and natural disasters. Motor vehicle accidents are reflected the most common cause of oral and maxillofacial trauma in many countries. Oral maxillofacial trauma is referred as the event when the facial region is injured, either alone or in conjunction with other fractures or injuries, including the head region. The most vulnerable area to fracture is the face itself, which is is one of the exposed part of our body and has lack of protection compared to other organ[1-7]. The prevalence of maxillofacial trauma is considered differs among the country. According to studies conducted in Singapore, New Zealand, Denmark, Japan, and the Middle East region which are the developed countries, motor vehicle accidents are considered the most common cause of maxillofacial fractures, whereas, in less economically developed countries such as parts of Sub-Saharan Africa and South Africa, maxillofacial injuries are more common due to interpersonal viciousness such as fights, assaults, and gunshots[8]. Oral maxillofacial fracture forms are consistently influenced by geographic region, cohort socioeconomic status, and investigation period[1]. Road traffic accidents are accepted as the most common cause of this fracture, followed by falls, assaults, sports, firearm injuries, and industrial accidents. Therefore, it is expected that the causes of fracture will influence the severity and type of fracture that occurs[7]. In brief, traumatic injury especially involving the maxillofacial region is still challenge to various level of health and need to be seriously studied and find the proper way to counter it.

In the mid-facial region, fractures of the orbital bone is one of its subtype which account for up to 40% of all trauma injuries in that region. Intraorbital pressure and force transmission through the bony walls are two commonly causes of orbital bone injuries. These fractures may be categorized into two main groups, those that involving the orbital rim and those in which the walls of the orbit are involved. Injury involving the orbital wall and adjoining soft tissue may cause significant functional and cosmetic complications such as diplopia, ocular muscle entrapment, and enophthalmos, significantly if the diagnosis of the fracture is delayed[9]. Therefore, the surgical treatment of orbital wall fractures aims to restore the anatomy by reconstructing the fractured orbital walls and reducing the herniated soft tissues. The leading cause of trauma in Malaysia is road traffic accidents. Malaysia is unique compared to from other countries because it has different races in the same country, mainly Malay community, followed by Chinese, Indian, and other ethnic groups[6]. Maxillofacial injuries are categorized into various types such as bone fractures, soft tissue injuries, and dentoalveolar injuries. Among these, mandible and mid-facial skeletal fractures are considered the most common type of involving the bone, while lacerations and tooth crown fractures are the most common causes of soft tissue and dentoalveolar injuries, correspondingly.

These injuries involve mainly the younger age group such as men between the ages of 20 and 40 are more prone to be impacted. Similar with other injuries, the oral and maxillofacial injuries can harm a person's ability to perform in full condition[3]. The region of head or face is where important functions such as the vision, hearing, olfaction, respiration, mastication, and speech occur. In this study, Hospital Universiti Sains Malaysia is choosen as it is one of the main government hospital located at east coast of Malaysia which is Kelantan state, covering a demographically sizeable populated area. As a university hospital with good facilities and specialists, maxillofacial fracture cases are often referred from states of eastern and northern Malaysia[5]. Oral Maxillofacial trauma and its treatment data occuring for five years based on a certain pattern was choosen in this study. This research aims to determine a proper relationship between broken or injured involving the orbital walls of the patients treated in the Oral Maxillofacial Clinic and Oral Maxillofacial ward, operating theatre Hospital USM in Kelantan, Malaysia.

2. Materials and Methods

The medical records of patients with maxillofacial fractures were treated at Hospital USM. from July 2013 to June 2018 in the Oral and Maxillofacial

Surgery (OMFS.) Unit, Hospital USM Kelantan, Malaysia, was reviewed retrospectively. According to the review record, road traffic accidents, fights, assaults, sports, falls, industrial accidents, and others were among the causes of the injuries. Therefore, data were collected under the variables: Seventeen recorded injured sites were included in this analysis. The injured were Zygomatic Complex Fracture, Zygomatic Arch Fracture, Nasal Fracture, Maxillary Sinus Fracture, Le Fort, I Fracture, Le Fort II Fracture, Le Fort III Fracture, Orbital Wall Fracture, Alveolar Process Fracture, Symphysis of Mandible Fracture, condyle of Mandible Fracture, Ramus of Mandible Fracture, Maxillary Bone Fracture and Mandibular Bone Fracture. The Statistical Package for the Social Sciences was used to conduct the statistical analysis (IBM SPSS, Chicago, IL, USA, software version 26.0). Because the data were categorical, descriptive and Spearman correlation analyses were used to determine the correlation strength among the fractured orbital wall.

The advantage of Spearman correlation is less sensitive to outliers due to Spearman's limits the outliers to the value of its rank. Correlation coefficients can be anywhere between 1.00 and +1.00. A perfect positive correlation is designated by a + 1.00 correlation value, while a 1.00 correlation value designates a perfect negative correlation. A value of 0.00 indicates no relationship between two calculated variables. Another interpretation is that when the value is r_s = 0.10 to 0.29 or r_s = −0.10 to −0.29, the correlation is weak, moderate when the value is r_s = 0.30 to 0.49 or r_s = −0.30 to −0.49, and strong when the value is r_s = 0.50 to 1.00 or r_s = −0.50 to −1.00 [2]. A path analysis was created based on the Spearman correlation analysis of the injured orbital wall. When it comes to real-life cases, this will help establish the connection between the injured bone and its corresponding skeleton part. Multiple response analysis is the next step after the analysis is complete. Multiple responses analysis determines the most common fracture among all studied fractures. A frequency table based on the variables of interest can be generated using it. As a result, we can figure out the most common factor.

3. Results

In this retrospective study, 294 patients with 196 maxillofacial fractures were included where it meets inclusion criteria; out of those, 228(77.6%) were male, and 66 (22.4%) were female. The frequency of patients' ages is shown in Table 1.

Table 1: Frequency of Patient's Age

In years	Frequency (*n*)	Valid Percent (%)
Less than one years	1	0.3
1-10 years	9	3.1
11-20 years	117	39.8
21-30 years	77	26.2
31-40 years	32	10.9
41-50 years	27	9.2
More than 50 years	31	10.5
Total	**294**	**100.0**

The frequency analysis found that 228(77.55%) are male, and 66(22.45%) are female. Figure 1 shows the gender frequency.

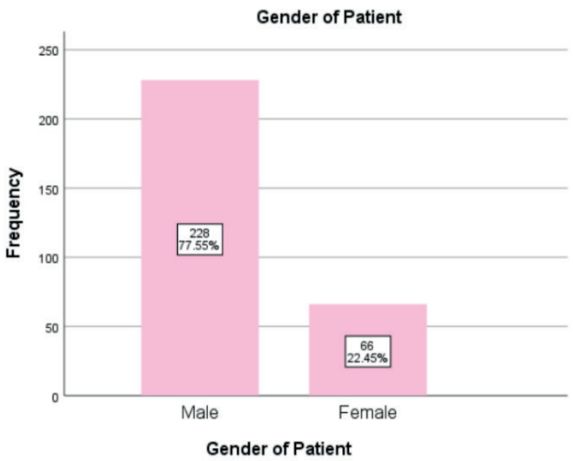

Figure 1: Frequency of the gender

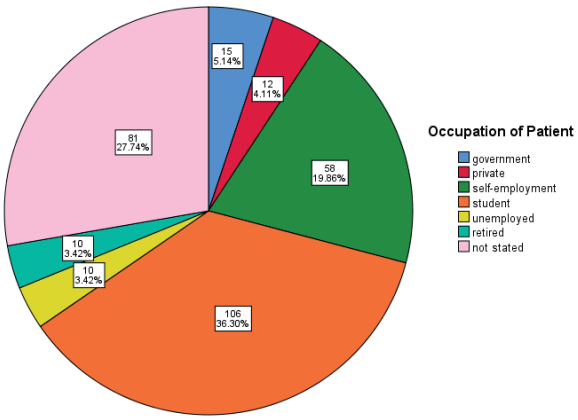

Figure 2: Occupation of patients

The patient's occupation is depicted in Figure 2. It was discovered that students, 106(36.30%) and self-employed individuals 58(19.86%) have the highest employment rates in the Pie chart. Therefore, during the five years from July 2013 to June 2018, the student is at greater risk of being injured.

Table 2: Correlation among the types of Orbital Wall fractures.

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Orbital Wall Fracture	1												
2	Zygomatic Complex Fracture	0.055	1											
3	Zygomatic Arch Fracture	0.127*	-0.129*	1										
4	Nasal Fracture	0.023	-0.011	-0.065	1									
5	Maxillary Sinus Fracture	0.180**	0.000	0.129*	0.026	1								
6	Le Fort I Fracture	-0.027	0.114	-0.035	0.010	-0.028	1							
7	Le Fort II Fracture	-0.096	-0.024	-0.010	0.154**	-0.091	0.153**	1						
8	Le Fort III Fracture	-0.035	-0.011	-0.056	0.038	-0.053	-0.057	0.111	1					
9	Alveolar Process Fracture	-0.049	0.036	-0.024	-0.030	-0.022	0.130*	0.109	-0.016	1				
10	Symphysis of Mandible Fracture	-0.161**	-0.182**	-0.046	-0.081	-0.086	-0.049	0.010	-0.001	-0.026	1			
11	Condyle of Mandible Fracture	-0.181**	-0.153**	-0.058	-0.108	-0.121*	-0.096	0.000	0.008	-0.037	0.269**	1		
12	Ramus of Mandible Fracture	-0.041	-0.053	-0.044	-0.057	-0.042	0.038	-0.053	-0.031	-0.013	0.182**	-0.010	1	
13	Maxillary Bone Fracture	0.371**	0.454**	0.191**	0.151**	0.207**	0.223**	0.258**	0.151**	0.063	-0.246**	-0.293**	-0.066	1

*. *Correlation is significant at the 0.05 level (2-tailed).*

**. *Correlation is significant at the 0.01 level (2-tailed).*

According to Table 2, the orbital wall fracture has a significant association with Zygomatic Arch Fracture (r_s = 0.127), Maxillary Sinus Fracture (r_s = 0.180**), Symphysis of Mandible Fracture (r_s =-0.161**), Condyle of Mandible Fracture (r_s = -0.181**), Ramus of Mandible Fracture (r_s = -0.041), and Maxillary Bone Fracture (r_s = 0.371**). This study can also see the indirect relationship between orbital wall fracture and other injuries. Table 3 also reveal that the maxillary bone fracture has also had the most association with other injured as such Orbital Wall Fracture (r_s = 0.371**), Zygomatic Complex Fracture(r_s = 0.454**), Zygomatic Arch Fracture(r_s = 0.191**), Nasal Fracture(r_s = 0.151**), Maxillary Sinus Fracture(r_s = 0.207**), Le Fort I Fracture(r_s = 0.223**), Le Fort II Fracture(r_s = 0.258**), Le Fort III Fracture(r_s = 0.151**), Symphysis of Mandible Fracture(r_s = -0.246**), and Condyle of Mandible Fracture(r_s =-0.293**).

Table 3: Multiple Response Analysis for Fracture Frequencies

N	Responses	
	Per cent (%)	
Orbital Wall Fracture	76	13.2%
Zygomatic Complex Fracture	88	15.3%
Zygomatic Arch Fracture	22	3.8%
Nasal Fracture	35	6.1%
Maxillary Sinus Fracture	20	3.5%
Le Fort, I Fracture	23	4.0%
Le Fort II Fracture	30	5.2%
Le Fort III Fracture	11	1.9%
Alveolar Process Fracture	2	0.3%
Symphysis of Mandible Fracture	27	4.7%
The condyle of Mandible Fracture	49	8.5%
Ramus of Mandible Fracture	7	1.2%
Maxillary Bone Fracture	185	32.2%
Total	575	100.0%
Multiple Response Analysis was Applied		

Table 3 summarises the most common injuries that have been reported in the last five years. The most common type of bone fracture is a maxillary bone fracture, which occurs in 185 (32.2%). The second highest is Zygomatic Complex Fracture 88(15.3%), followed by Orbital Wall Fracture 76(13.2%). Next, the condyle of Mandible Fracture, 49(8.5%), Le Fort II Fracture 30(5.2%), Nasal Fracture 35(6.1%), Symphysis of Mandible Fracture 27(4.7%), Le Fort, I Fracture 23(4.0%), Zygomatic Arch Fracture 22(3.8%), Maxillary Sinus Fracture 20(3.5%), Le Fort III Fracture 11(1.9%), Ramus of Mandible Fracture 7(1.2%), and Alveolar Process Fracture 2(0.3%).

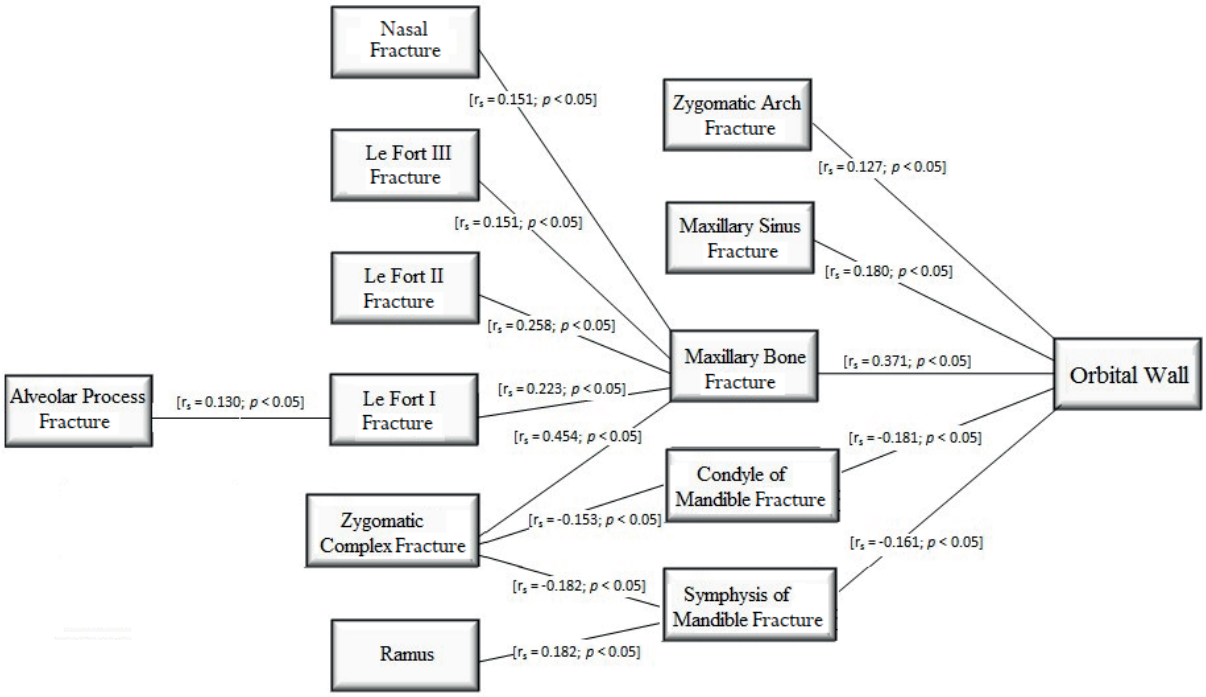

Figure 3: Path Analysis Using Spearman Correlation Modeling

According to the results of the path analysis, five variables were associated with the fracture to the orbital wall in this case. Zygomatic Arch Fracture (r_s = 0.127; p < 0.05), Maxillary Sinus Fracture(r_s = 0.180; p < 0.05), Maxillary Bone Fracture (r_s = 0.371; p < 0.05), The condyle of Mandible Fracture (r_s = 0.181; p < 0.05), and Symphysis of Mandible Fracture (r_s = 0.161; p < 0.05). From the path analysis, five variables have the association to Maxillary Bone Fracture, Nasal fracture (r_s = 0.151; p < 0.05), Le Fort III fracture (r_s = 0.151; p < 0.05), Le Fort II fracture (r_s = 0.258; p < 0.05), Le Fort I fracture (r_s = 0.223; p < 0.05), and Zygomatic Complex Fracture (r_s = 0.454; p < 0.05). It was found that Zygomatic Complex Fracture have an association with condyle of Mandible Fracture (r_s = 0.153; p < 0.05) and Symphysis of Mandible Fracture (r_s = 0.182; p < 0.05). While Ramus fracture has an association with Symphysis of Mandible Fracture (r_s = 0.182; p < 0.05).

4. Discussion and Conclusion

According to the study for five years of the patient records, the most common type of maxillofacial bone fracture is a maxillary bone fracture, which occurs in 185 (32.2%). This could due to the maxilla is the mid part of the face which prone to be injured especially related to motorvehicle accident such as motorcycle. The second highest is Zygomatic Complex Fracture 88(15.3%), followed by Orbital Wall Fracture 76(13.2%). Zygomatic bone is region very near to maxilla in term of anatomy and this could be related to maxilla injury as well. Orbit region is area close to maxilla and zygomatic bone which logically will be involved as well in the accident. Other reason could be the impact from the maxilla and zygoma which transmitted to the orbit and injured the region.

In general, men are more likely to be exposed to the prevalence of orbital wall fracture, about 76.3% compared to females (23.7%). This could be attributed

to the male more using motorcycle compared to female. This study discovered that the Malay ethnic group has a prevalence of 98.7%, and the Chinese ethnic group has roughly 1.3%. This could due to Malay is predominant races in Malaysia. The analysis found that patients between 11-20 years old are more exposed to orbital wall fracture 117(39.8%) than other age groups. Patients between the ages of 21 and 30 were the second most vulnerable to orbital wall fracture. Younger age group combine with male is age where is one the most active life on the road usage. The student which also within this group and gender is related to the accident as well. This finding was consistent with the study done by[5]. But the contrast with the study by[7] in Pakistan, which said that the age group 21-30 contributes the highest incidence.

This information will assist a clinician in managing an orbital wall fracture efficiently and to the educators and higher authority to alert the contributed group to be more alert in the road.

This paper provides the proportion of orbital wall injuries among patients treated for maxillofacial trauma at the Hospital Universiti Sains Malaysia. Among the maxillofacial injury, the orbital fracture is the third commonly found in Hospital USM. This can be related to the eastern region of Malaysia as well as this hospital is one of the main hospital in Malaysia. This study also investigates the most frequently occurring orbital wall fracture the association among the maxillofacial injury. In this study, Spearman correlation was used to determine the most common fracture related to the orbital wall. In conclusion, our data confirm that orbital wall injuries were associated with the five variables, which were Zygomatic Arch Fracture ($r_s = 0.127$; $p < 0.05$), Maxillary Sinus Fracture($r_s = 0.180$; $p < 0.05$), Maxillary Bone Fracture ($r_s = 0.371$; $p < 0.05$), The condyle of Mandible Fracture ($r_s = 0.181$; $p < 0.05$). The path analysis technique of spearman correlation modelling captured the entire scene involving the orbital wall fracture. The path analysis shows that Zygomatic Arch Fracture, Maxillary Sinus Fracture, and Maxillary Bone Fracture directly correlate to the orbital wall. That is, when the orbital wall is injured, the Zygomatic Arch, Maxillary Sinus, and Maxillary Bone are also likely to be injured. In term of anatomy, orbit region is near to the maxilla and zygomatic bone, and this mathematical relation further strengthening the fact. This finding will provide a clear picture of the most common fracture and better understand the sources of orbital wall fracture in maxillofacial trauma. Findings are also essential for future planning, particularly for preparing for the most common treatment based on the results. Orbital fracture is a must suspected in any maxillofacial injury so that prompt treatment is needed in urgent and therefore save the region and vital organs such as eye in the younger age group.

5. Acknowledgment

This study was funded by the Ministry of Higher Education (MoHE) Fundamental Research Grant Scheme (FRGS.) 203.PPSG.6711666, the authors would like to thank Universiti Sains Malaysia (USM).

6. Conflicts of Interest

There are no conflicts of interest.

7. Ethical clearence

The patient's medical records were reviewed after getting permission from the Director, Hospital USM. Ethical approval was taken from the Human Research Ethics Committee of USM (JEPeM) , JEPeM Code: USM/JEPeM/19010030.

8. Author's contribution:

Data gathering and idea owner of this study: WMAWA, NFMN, RS, NANR, MNA, FMMG, NANA, NAA.

Study design: WMAWA, NFMN, RS, MNA, FMMG, MAY, NANA, NAA.

Data gathering: WMAWA, NFMN, RS, NANR, MNA, FMMG, NAA.

Writing and submitting manuscript: WMAWA, NFMN, RS, NANR, MNA, FMMG, MAY, NANA, NAA and MKA

Editing and approval of final draft: WMAWA, NFMN, RS, NANR, MNA, FMMG, MAY, NANA, NAA and MKA

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